CONTAMINANT CONCENTRATIONS AND TRENDS IN PUGET SOUND HARBOR SEALS

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Objectives

- Determine concentrations of a broader range of contaminants than previously (PCB congeners, dioxins and furans)

- Examine trends in contaminants through from the 1970s to the late 1990s

- Evaluate toxic risk of current contaminant loads to harbor seals

Harbor seals

- Abundant
- Coastal distribution
- Near contamination
- Feed on fish
- Long lived
- Well studied
- Captive studies

Sampling locations
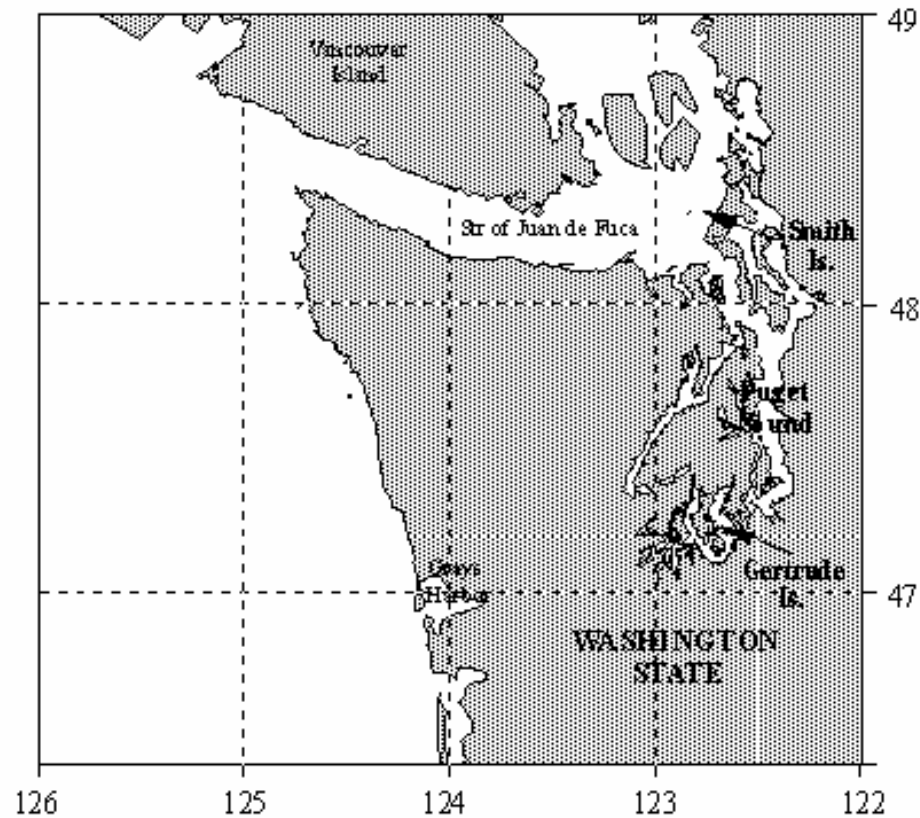
Harbor seal samples from S Puget Sound analyzed by type and year

Type	PCBs, PCDFs & PCDDs	Pesticides
Biopsy samples from captured weaned pups		
1993	11	11
1996	17	12
Total weaned pups	28	23
Samples from fresh dead neonates		
1984	10	10
1990	10	10
1996	4	4
1997	5	5
Total neonates	29	29
Total different samples	57	52

Concentrations (by wet weight) in blubber of Puget Sound seals

Type/Year	n	PCBs ppm	PCDDs ppt	PCDFs ppt	TEQ ppt
Biopsied live weaned pups					
1993	11	9.9	1043	43.6	116
1996	17	14.3	120	10.3	131
All biopsies	28	12.6	483	23.4	125
Dead neonate pups					
1984	10	17.6	112	6.6	156
1990	10	14.2	114	23.5	175
1996	4	11.2	119	19.3	105
1997	5	9.4	59	9.7	66
All neonates	29	14.1	105	15.2	140
All samples	57	13.4	290	19.4	133
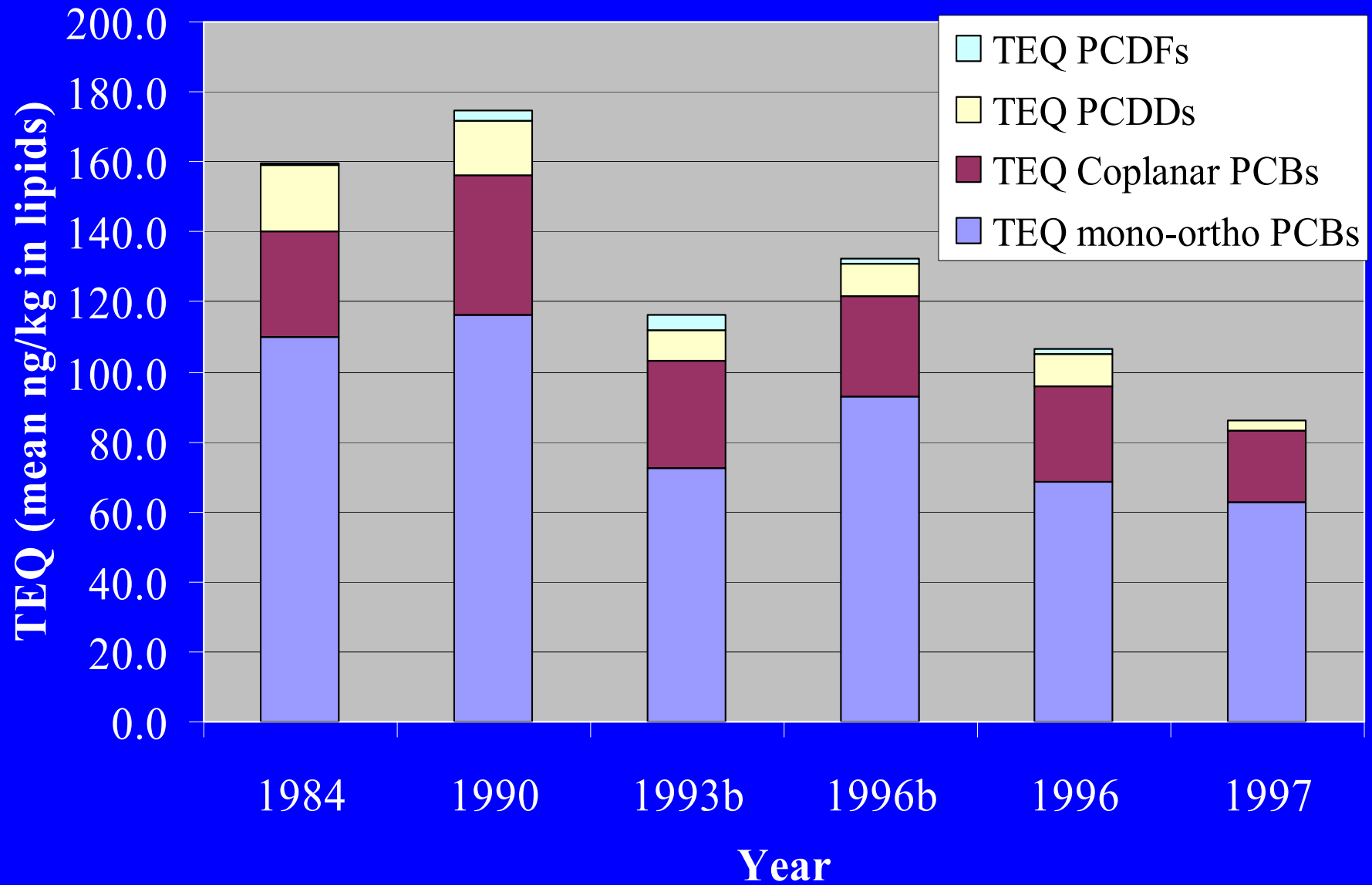
TEQ in seal pups by year
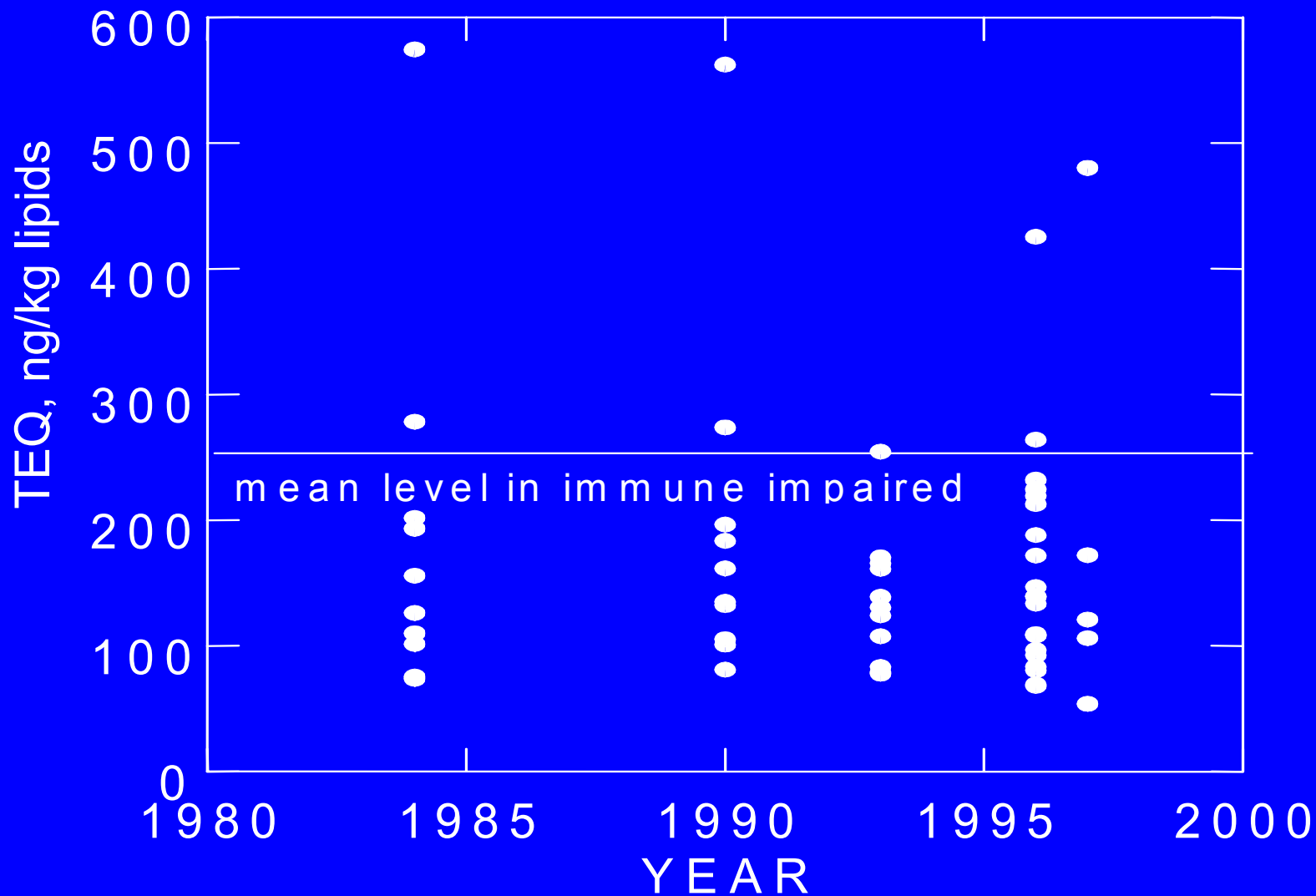
Multiple regression with total PCB

Dep Var: TPCB   N: 54   Multiple R: 0.453   Squared multiple R: 0.205
Adjusted squared multiple R: 0.140   Standard error of estimate: 7.930

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	1025.702	588.567	0.000	.	1.743	0.088
YEAR	-0.525	0.295	-0.285	0.635	-1.781	0.081
BD	14.238	5.325	0.840	0.164	2.674	0.010
WTKG	-1.414	0.460	-1.054	0.138	-3.076	0.003
LENCM	0.416	0.204	0.379	0.470	2.041	0.047

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	794.755	4	198.689	3.160	0.022
Residual	3081.223	49	62.882		

# Multiple regression with total DDTs

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Dep Var: TOTDDTS    N: 49    Multiple R: 0.505    Squared multiple R: 0.255
Adjusted squared multiple R: 0.187    Standard error of estimate: 1.404
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Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	202.450	106.891	0.000	.	1.894	0.065
YEAR	-0.103	0.053	-0.313	0.648	-1.937	0.059
BD	3.274	0.973	1.051	0.173	3.364	0.002
WTKG	-0.291	0.083	-1.173	0.150	-3.491	0.001
LENCM	0.065	0.039	0.306	0.507	1.672	0.102

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	29.710	4	7.427	3.768	0.010
Residual	86.728	44	1.971		

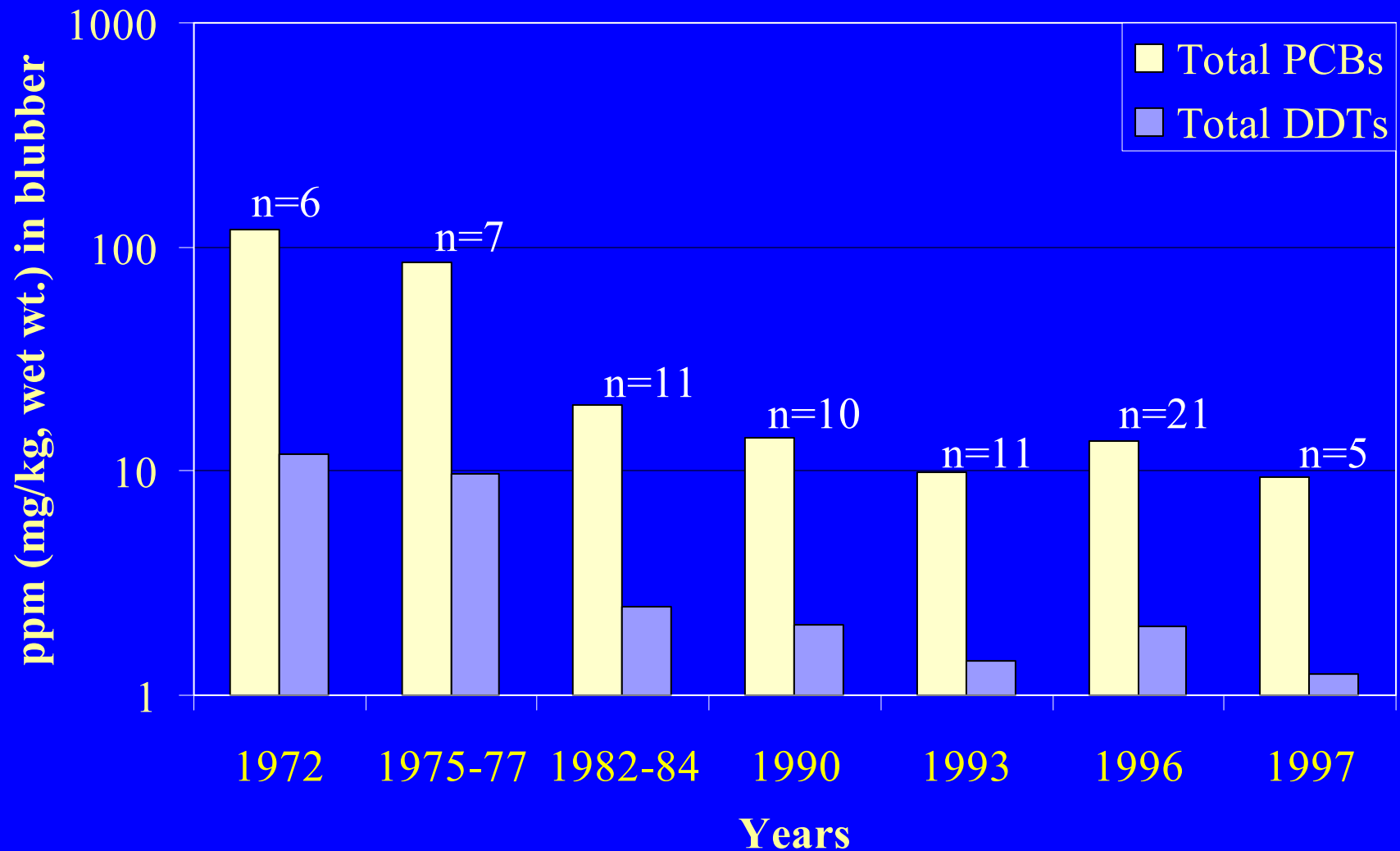---

# Changes in PCB composition over time in Puget Sound seals
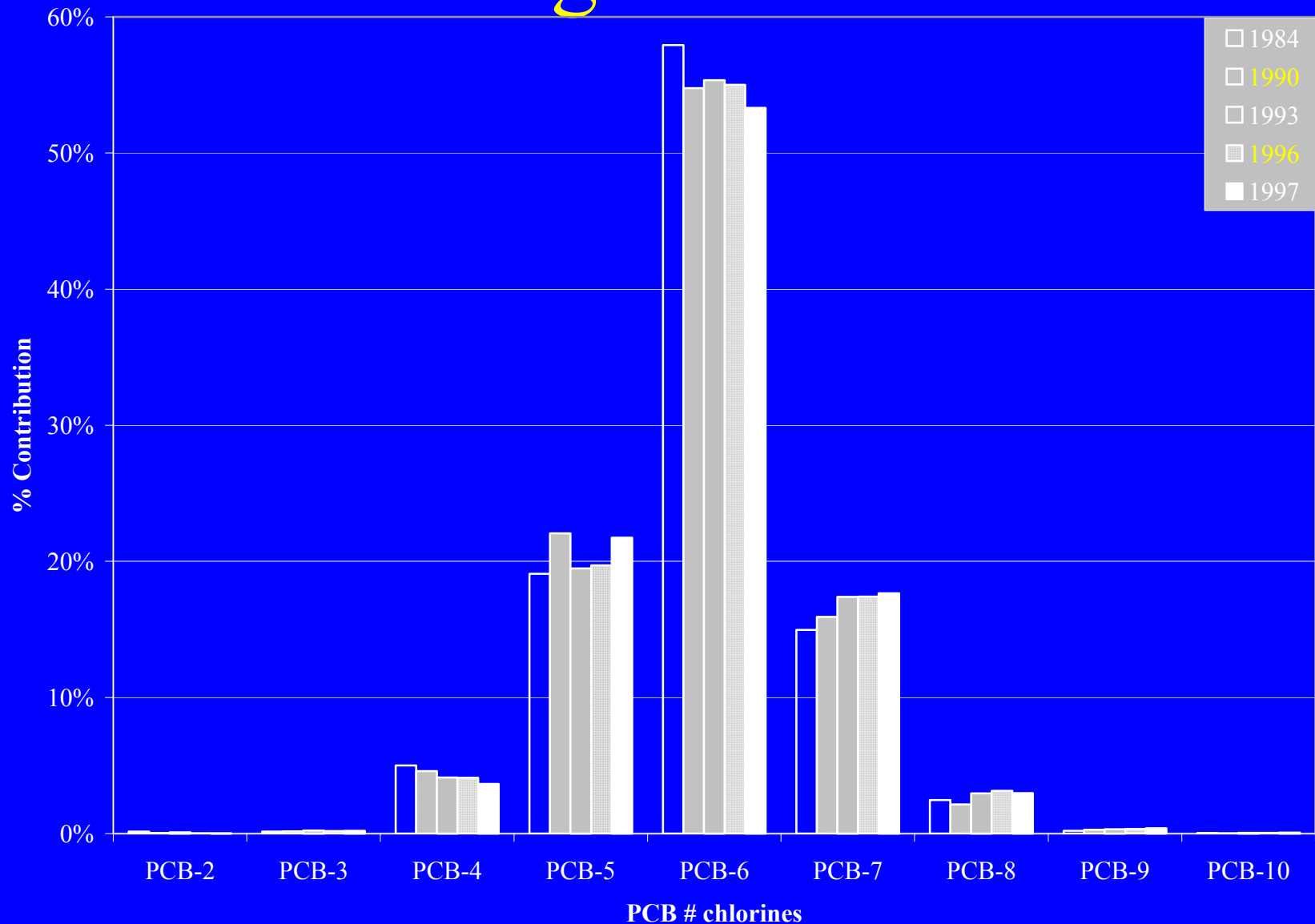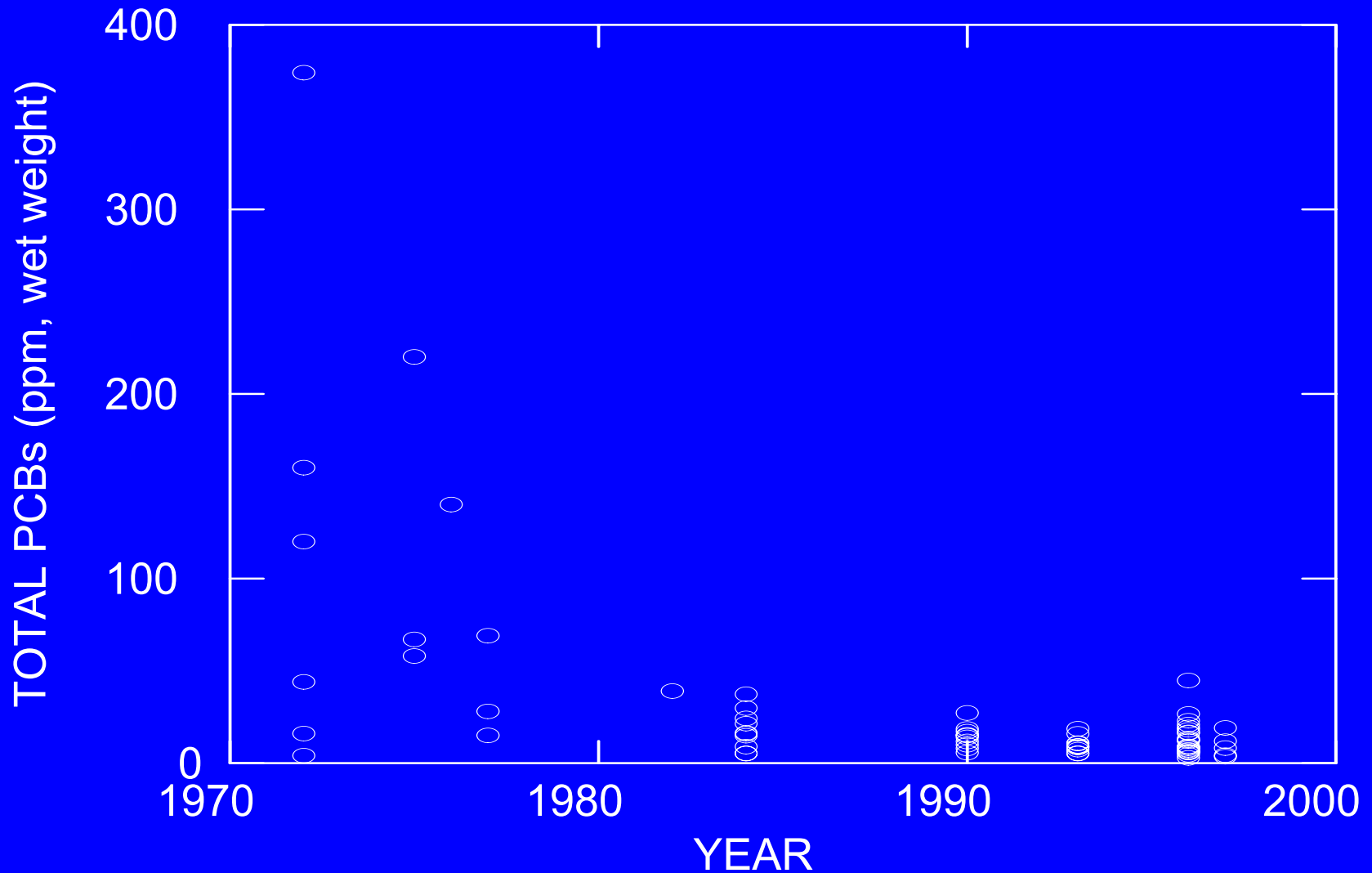
Trends in S Puget Sound pups

PCB/DDT trends over time

- Highly significant declines since 1970s
- Declining trend since 1984 but not statistically significant
- Other factors affecting concentrations
  - Biopsy/dead samples
  - Pup length
  - Pup weight
- Declining trend approaches significance ($p<0.10$) with covariates in multiple regression

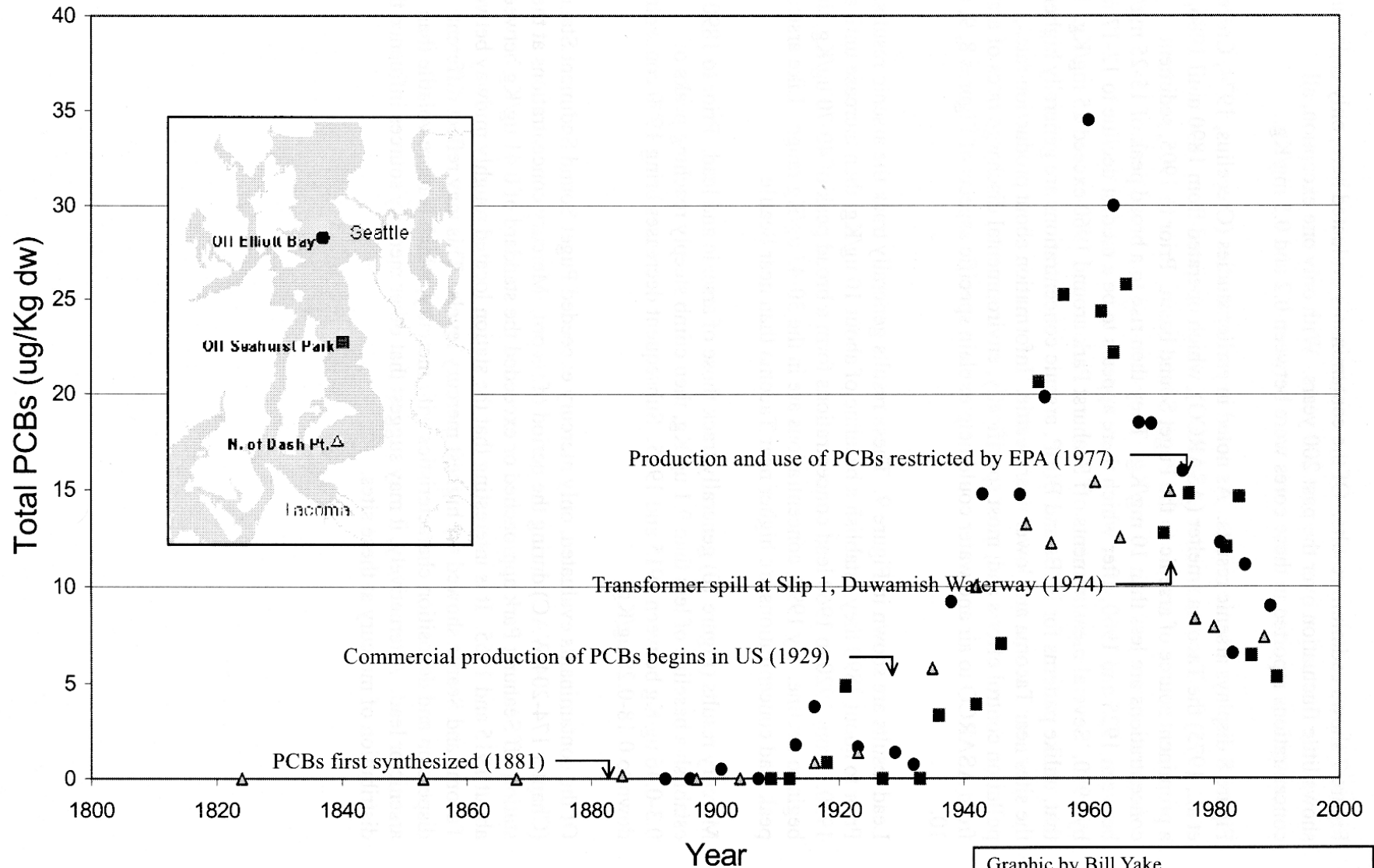Trends in PCBs in harbor seals from Smith Is., Str. Juan de Fuca
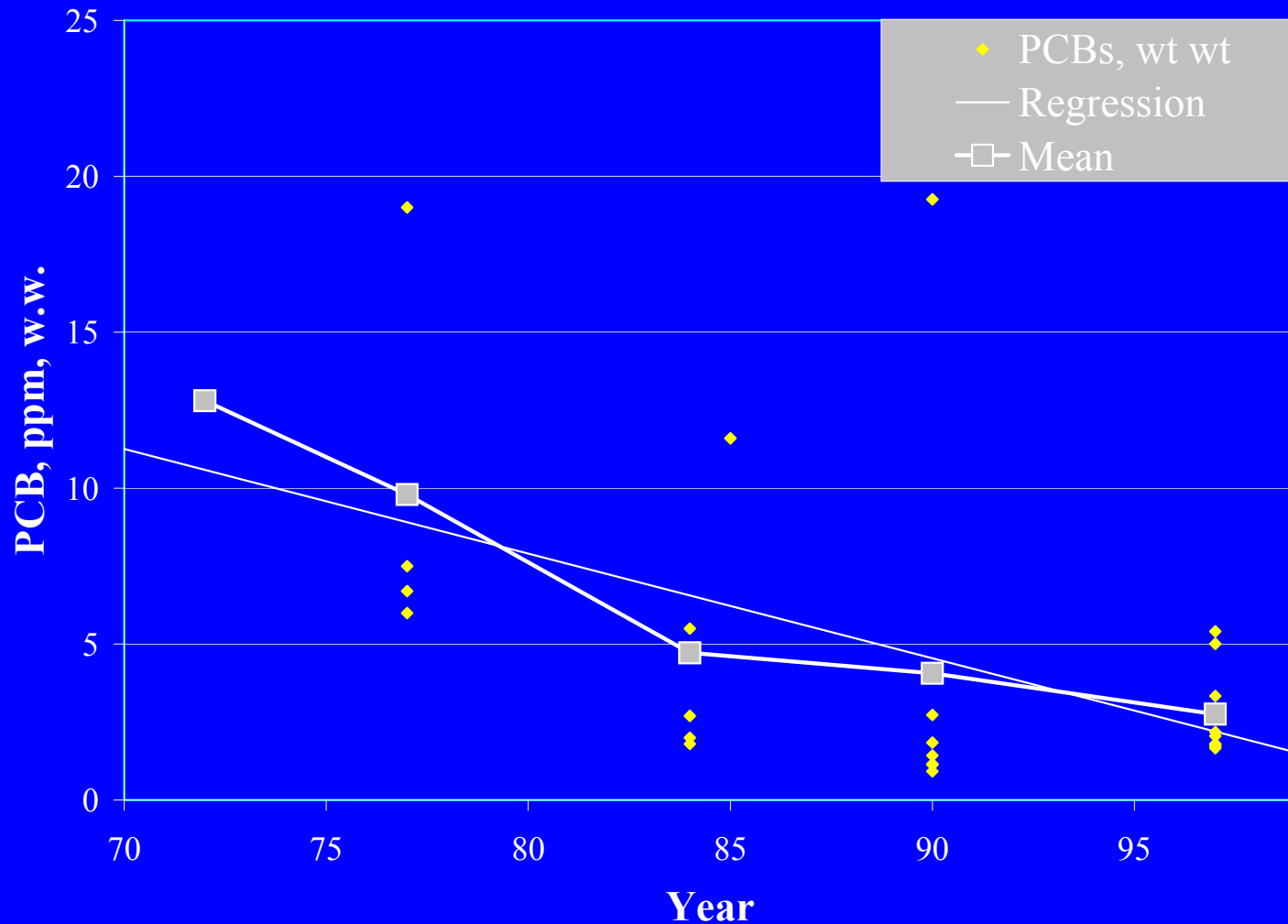
Trends in DDTs in harbor seals from Smith Is., Str. Juan de Fuca
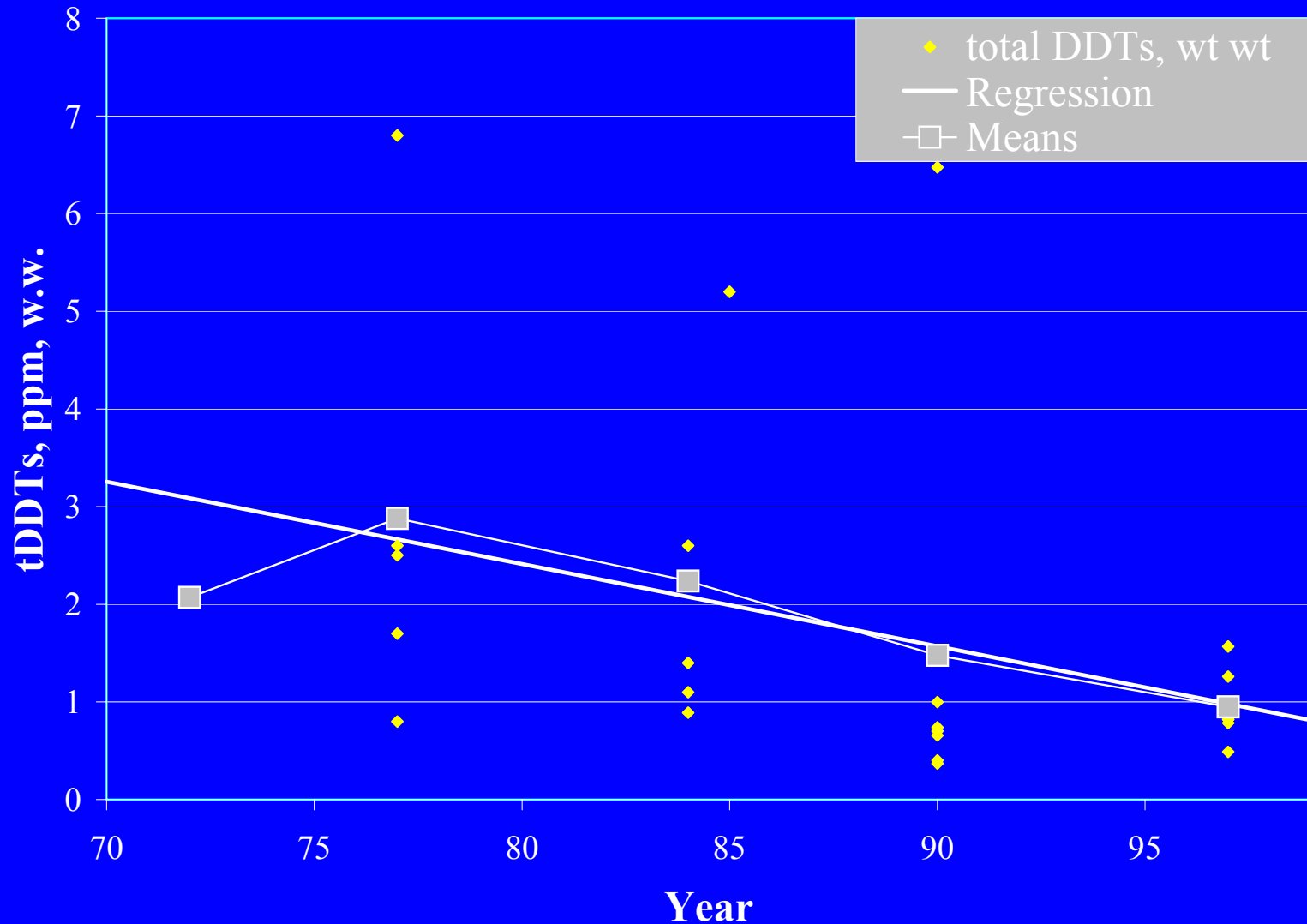
# Trends in other contaminants

- Statistically significant declines 1984-97
  - Total chlorobenzenes
  - HCB
  - Total chlordanes
- Downward trends short of significance
  - Total heptachlor
  - Total DDTs
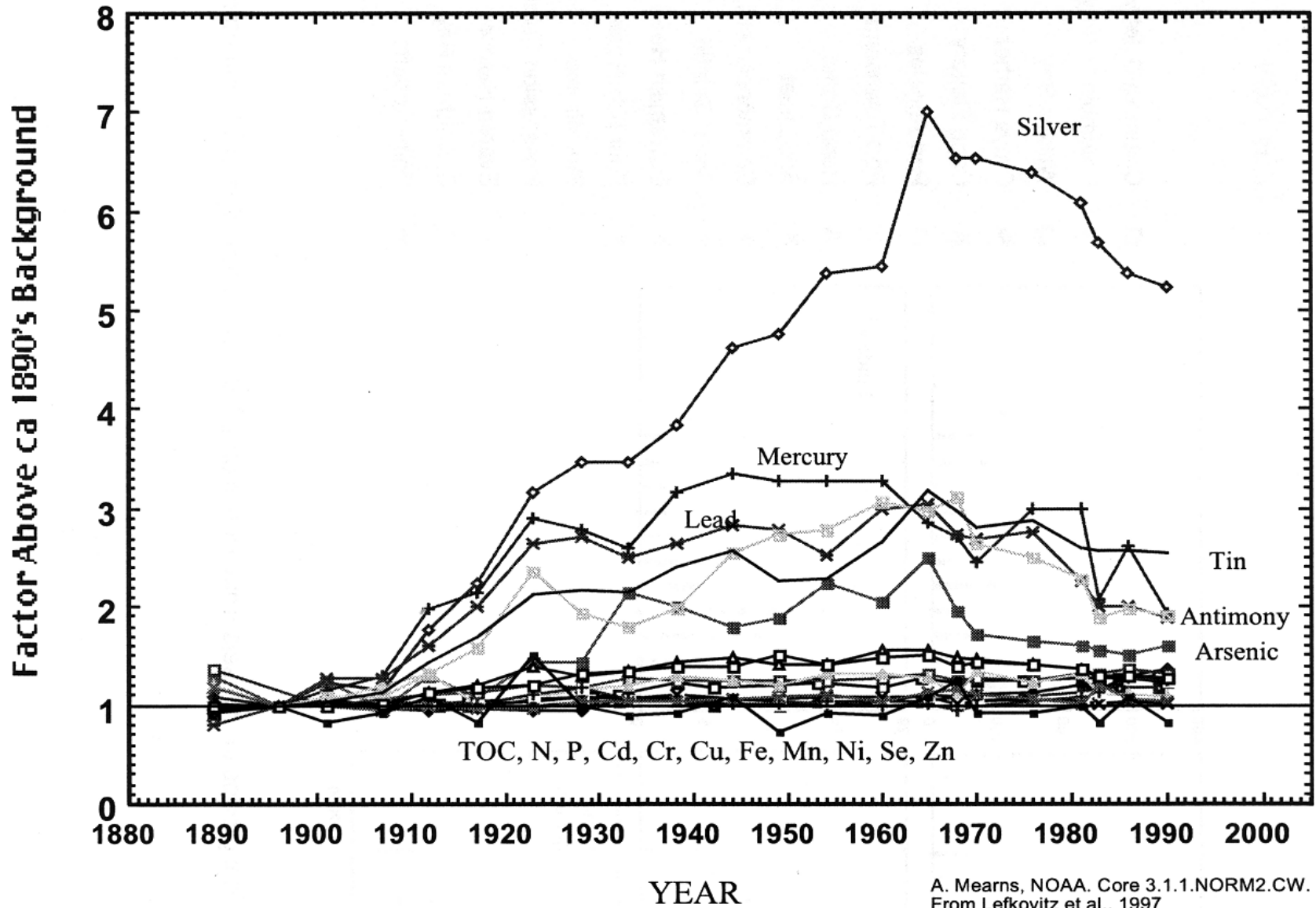 - Dioxins

Trends in PCBs from sediment cores

Graphic by Bill Yake
Sediment Core Data - Lefkovitz, et al., 1997.

Trends in DDTs from sediment cores

Graphic by Bill Yake
Sediment Core Data - Lefkovitz, et al., 1997.
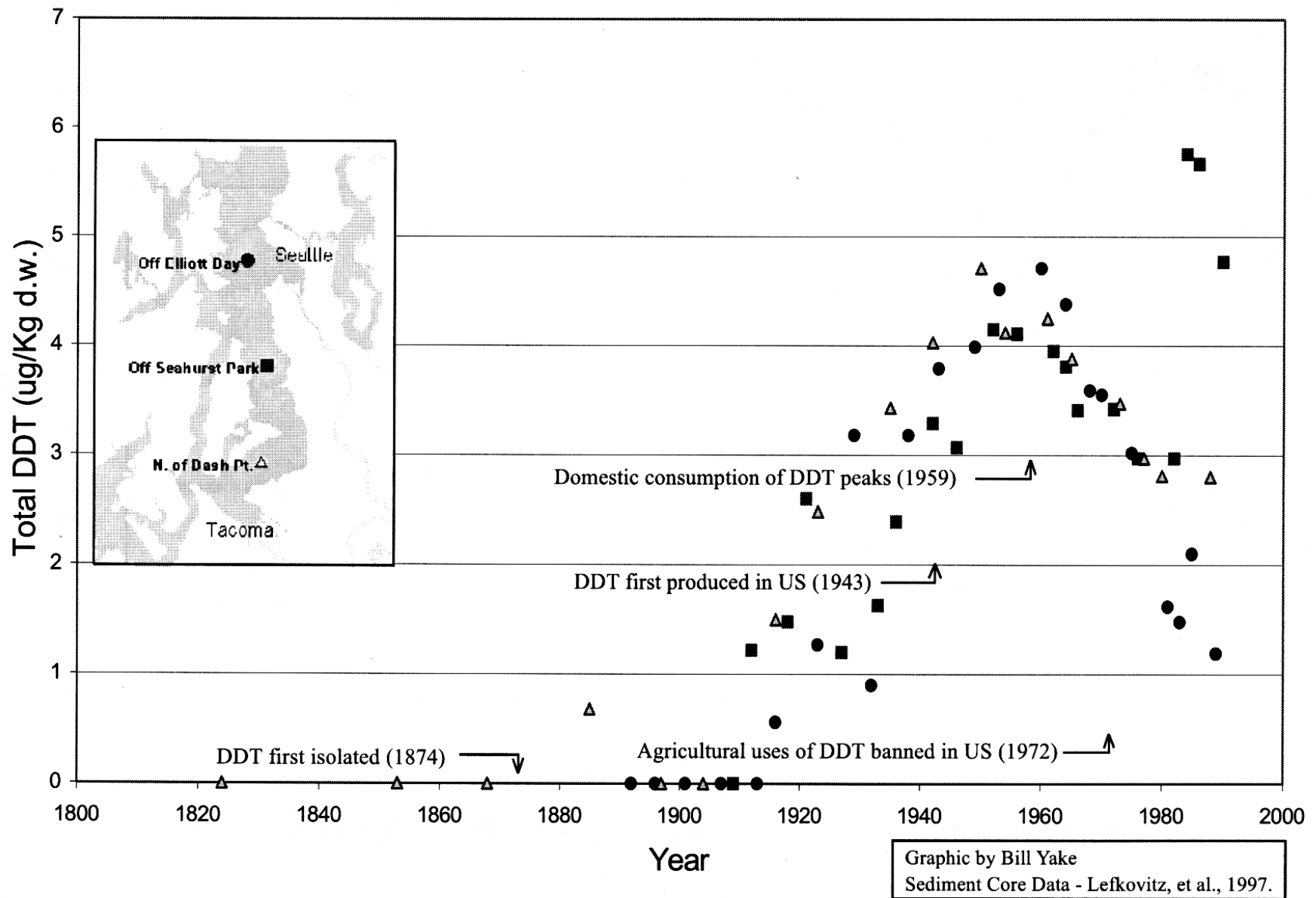
Trends in metals from sediment cores

A. Mearns, NOAA. Core 3.1.1.NORM2.CW.
From Lefkovitz et al., 1997

Implications for other species

Temporal trends from different view points

➔ Spatial view

(a)

Restriction

Levels

Point source
(Local Discharges)

Away from
the source
(Terrestrial
Environment)

Remote from
the source
(Open Ocean)
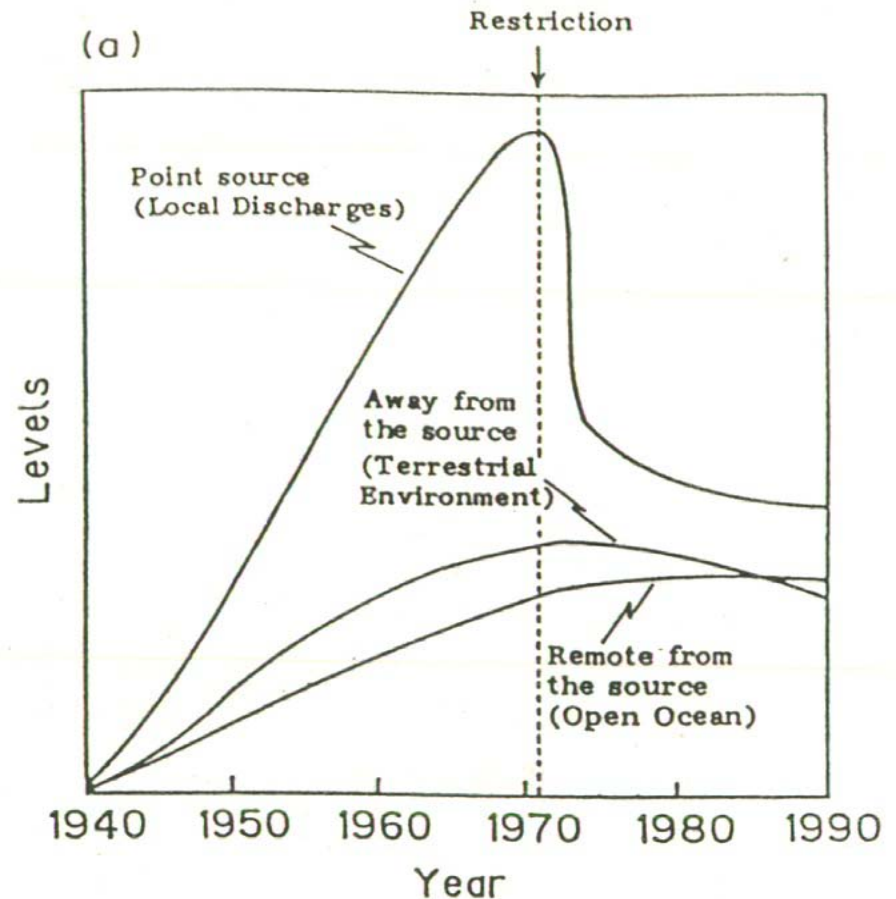
1940 1950 1960 1970 1980 1990

Year

Fig. 1a   Schematic representation of the temporal trends of persistent man-made chemicals from a spatial view point.

Temporal trends from different view points
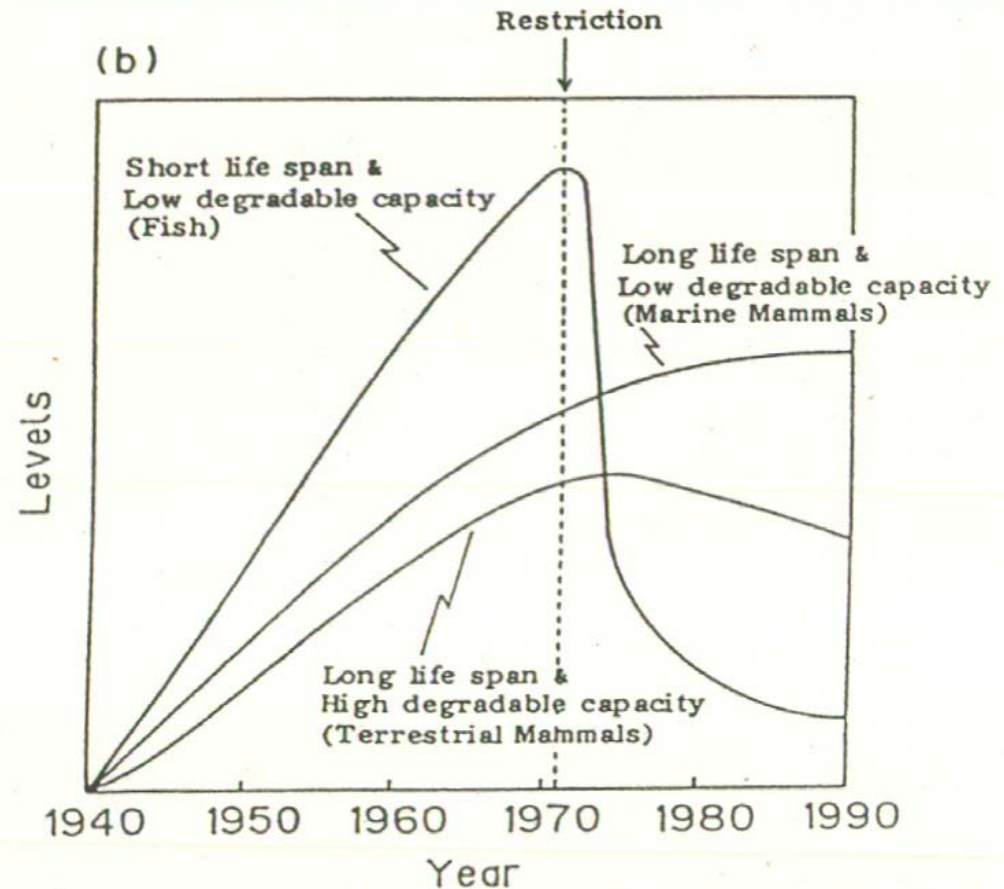
• Spatial view

➜ Biological

Fig. 1b Schematic representation of the temporal trends of environmental contamination by persistent man-made chemicals from a biological view point.

Temporal trends from different view points

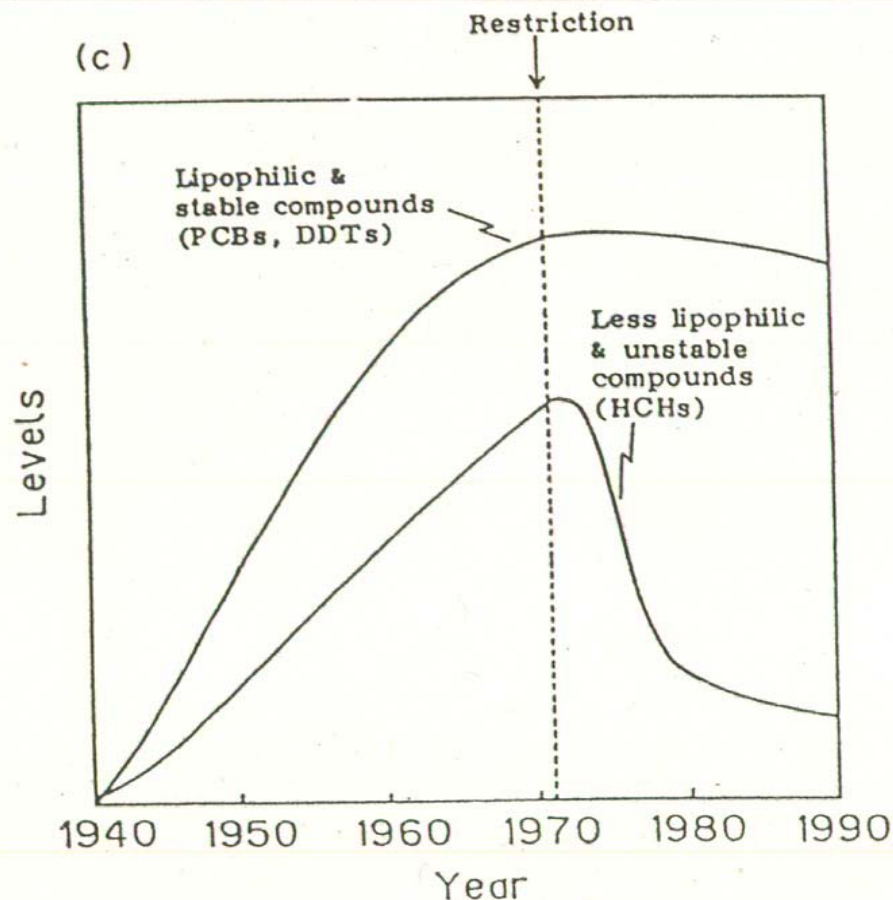- Spatial view

- Biological

➡ Chemical

Fig. 1c Schematic representation of temporal trends of environmental contamination by persistent man-made chemicals from a chemical characteristics view point.

Harbor seal - killer whale differences

- Diet

- Life-span

- Reproduction

- Habitat

- Range

Gray whale mortality

Conclusions for harbor seals

- PCBs & DDTs have declined in harbor seals since the 1970s, levels have stabilized in recent years

- Primary risk (measured by TEQs) comes from PCBs and not PCDDs or PCDFs

- PCBs and TEQs remain high and similar to those known to cause immune dysfunction

Implications for killer whales

- Unlike harbor seals, sources of CH contaminants for killer whales mostly from outside region

- Decreasing contaminant exposure in killer whales requires global action

- Contaminant concentrations in killer whales have been as high or higher than currently for >30 years

- Contaminants likely declining in killer whales but at much slower rate than for harbor seals